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Office of the Chief Technical Report

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PrairieWatch

Quality Assurance Project Plan

by
Alice Brandon
Illinois EcoWatch QA/QC Officer

June 2003

ILLINOIS
NATURAL
HISTORY
SURVEY

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PRAIRIEWATCH QUALITY ASSURANCE PROJECT PLAN

for

Illinois EcoWatch Network

PrairieWatch Program

Illinois Department of Natural Resources

1 Natural Resources Way

Springfield, IL 62702

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Spring 2003

APPROVALS:

EcoWatch Project Coordinator	Date
EcoWatch Quality Assurance Officer	Date
PrairieWatch Program Coordinator	Date
PrairieWatch Training Coordinator	Date

Table of Contents

3.0 QUALITY ASSURANCE PROJECT PLAN DISTRIBUTION LIST

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4.0 THE CTAP/ECOWATCH ORGANIZATION

Illinois PrairieWatch (PW) is the prairie-monitoring component of the Illinois EcoWatch Network (EW), a volunteer monitoring program coordinated through the Division of Ecosystems, Office of Realty and Environmental Planning, in the Illinois Department of Natural Resources (IDNR). EW is a component of the Critical Trends Assessment Program (CTAP), an umbrella program developed in 1995 to monitor trends in Illinois ecosystems. Scientists and staff at the Illinois Natural History Survey (INHS) and Illinois EW collaborated to develop the CTAP professional and volunteer monitoring programs for Illinois forests, streams, wetlands, and prairies. The CTAP team consists of staff from IDNR's Office of Realty and Environmental Planning and the Office of Research and Scientific Analysis including the Illinois State Geological Survey, Illinois Waste Management and Research Center, INHS, and the Illinois State Water Survey. In CTAP, the collective knowledge and judgment of professionals and EW staff, taking into account the resources available, have developed protocols for volunteer use in these ecosystems.

Funding for the development and implementation of EW primarily comes from Conservation 2000 and other IDNR sources. Previously (1995–2000), EW was supported through AmeriCorps, a national volunteer service program created by President Clinton and Congress in 1994.

PrairieWatch Staff

A list of PW personnel, their job responsibilities, and where they are housed is provided in Table 1. PW also receives technical support from other CTAP staff at the Illinois Natural History Survey.

TABLE 1. PERSONNEL FOR THE PRAIRIEWATCH PROGRAM.

Name/Title	Responsibilities	Agency/Division
John Marshall—Ecosystem Monitoring Section Manager	Oversees EW & integration with other IDNR programs including C2000.	IDNR—Division of Ecosystems
Dana Curtiss—EcoWatch Program Coordinator	Coordinates all EcoWatch Programs.	IDNR—Division of Ecosystems
Pete Jackson—PrairieWatch Program Coordinator	Coordinates PrairieWatch Program.	IDNR—Division of Ecosystems
Matt Buffington—PrairieWatch Training Coordinator	Trains and certifies EW Trainers on PW procedures, supervises all volunteer training procedures.	INHS—Office of the Chief
Alice Brandon—QA Officer	Ensures data meets data quality objectives, provides technical assistance.	INHS—Office of the Chief
Amy Osterman—EcoWatch Database Manager & Web master	Designs and manages EcoWatch databases and Web site.	INHS—Office of the Chief
Will Hinsman—Geographic Information Systems	Manages, analyzes, and maps geographic data for EcoWatch.	IDNR—Division of Ecosystems
Vacant—Region 1 EcoWatch Trainer	Recruits, trains, & coordinates volunteer monitoring effort at the regional level.	INHS—Office of the Chief
Vacant—Region 2 EcoWatch Trainer	Recruits, trains, & coordinates volunteer monitoring effort at the regional level.	INHS—Office of the Chief
Vacant—Region 3 EcoWatch Trainer	Recruits, trains, & coordinates volunteer monitoring effort at the regional level.	INHS—Office of the Chief
Vacant—Region 4 EcoWatch Trainer	Recruits, trains, & coordinates volunteer monitoring effort at the regional level.	INHS—Office of the Chief
Vacant—Region 5 EcoWatch Trainer	Recruits, trains, & coordinates volunteer monitoring effort at the regional level.	INHS—Office of the Chief

Partnerships

EW has multiple partners at the local and state levels. High schools, conservation groups, government agencies, and businesses support the program, including the Audubon Society, The Nature Conservancy, Cypress Creek National Wildlife Refuge, and the Illinois Chapter of the Sierra Club. EW partners with Chicago Wilderness to recruit and train high school science teachers, members of The Nature Conservancy's Volunteer Stewardship Network, and other volunteers in the northeastern Illinois region.

EW also works closely with the Conservation 2000 (C2000) Ecosystems Program, which provides Ecosystem Grants to Ecosystem Partnerships—coalitions of local stakeholders united by a common interest in the natural resources of their watershed. Ecosystem Partnerships and EW work together to monitor prairies and inform stakeholders about the importance of prairie ecosystems at the local level. C2000 has recently suggested that partnerships use PW protocols or CTAP professional protocols to monitor the performance of prairie restoration projects funded by C2000 grants.

Data Uses and Users

The CTAP program is the primary user of PW data. PW data were a critical component of the IDNR report entitled *Critical Trends in Illinois Ecosystems* (IDNR 2001a). This report describes the condition of the state's prairies, forests, streams, and wetlands based on CTAP professional scientist and volunteer data. Assemblages of organisms used in the CTAP monitoring to assess prairies include cover of sensitive native plant species, density and cover of invasive plants, abundance of indicator butterfly species, and terrestrial insect diversity (Bailey et al. 2000). Other important PW data users include, but are not limited to, C2000 Ecosystem Partnerships, private landowners, professional scientists, watershed-based organizations, and local communities.

5.0 BACKGROUND FOR VOLUNTEER MONITORING

History of Volunteer Monitoring

Streams and rivers have a long history of volunteer monitoring in the United States starting with Maryland's Save Our Streams (SOS) Program in 1969 (Firehock and West 1995). Volunteer monitoring is now a nationwide effort with over 772 programs in the U.S. (U.S. EPA 1998a). Most of these volunteer programs survey benthic macroinvertebrates for use in assessing stream quality (Firehock and West 1995; Penrose and Call 1995; US EPA 1998a). A much smaller number of programs monitor terrestrial systems for specific management concerns such as invasive plants or to monitor trends in species' demographics such as Ohio's Long-term Monitoring of Butterflies hosted in part by the Ohio Biological Survey (Ohio Department of Natural Resources 2003).

Parks, preserves, and privately managed prairies use volunteers to monitor prairie remnants and/or assist in restoration activities (Brown et al. 2001). However, PW is the only known statewide, state-sponsored volunteer program to measure long-term trends in prairies (with the exception of Ohio's butterfly monitoring program which is restricted to butterfly monitoring).

6.0 PROGRAM DESCRIPTION

As the volunteer prairie-monitoring component of CTAP, PW coordinates a statewide network of volunteers collecting information on Illinois prairies.

PrairieWatch Goals

The primary goals of the PW Program are to:

1. provide high-quality, credible data measuring changes in prairie habitat conditions over time;
2. educate Illinois citizens about the ecology and importance of prairies; and
3. promote volunteer stewardship of prairies at the local level.

Basic Sampling Design

PW describes its sampling procedures in the *Illinois PrairieWatch Monitoring Manual* (IDNR 2001b) and in sections of this QAPP. The PW program staff recognized from the outset that volunteer monitoring created a number of data quality challenges. First, to obtain large numbers of volunteers in a wide geographic area would necessitate recruiting individuals with varying levels of expertise in identifying plants and butterflies. Second, equipment would have to be simple and low-cost since many groups would be monitoring simultaneously. Lastly, because of the previous constraints, PW expected volunteers to collect less detailed information than would be collected by professional biologists.

Volunteers collect data during an every-other-year cycle. The plant and land use survey includes:

1. identifying and counting woody vegetation (shrubs, tree seedlings/saplings, and mature trees);
2. estimating cover of total herbaceous vegetation (% grasses/sedges and % broad-leaved herbaceous plants);
3. estimating cover of individual plant indicator species (includes both sensitive native,

common native, and invasive plant species); and

4. documenting surrounding land use.

The butterfly survey includes:

1. Recording the presence and abundance of selected indicator butterfly species known to frequent Illinois prairies.

PW uses a range of ecological indicators for monitoring prairies since there is no single measure that will reflect broad prairie conditions and sources of degradation (Schwartz et al. 1997). Volunteers use a simplified monitoring design based upon those used by CTAP botanists (Carroll et al. 2003). A less rigorous method, where not all taxa are identified to the species level, is necessary to accommodate volunteers with varying skill levels. The rationale for the chosen measures is as follows:

1. Disturbance sensitive native and common native forbs and grasses are measured to provide information on the diversity of prairie plants; many of these species are also good indicators of anthropogenic disturbance and vegetation quality (Schwartz et al. 1997).

2. Volunteers monitor invasive grasses, forbs, shrubs, and trees because they are widely recognized as a leading source of prairie degradation (IENR 1994; Schwartz et al. 1997).

3. Volunteers monitor adult indicator butterfly species that have varying tolerances to environmental degradation. This provides an indirect measure of rare plant taxa since many butterfly larvae are host-specific and the presence of the adults on site provides some evidence of the presence of these plants species at or near the site (Arenz 1995; Bouseman and Sternburg 2001).

Type of Prairie Monitored

All prairies monitored by the PW program must, as a minimum:

1. have less than 50% of area covered by shrub or tree canopy;
2. must contain prairie plant species; however, both restorations and reconstructions are acceptable (agricultural fields or areas that are frequently mowed are not acceptable);
3. must be at least 1000 m^2 with the shortest side at least 10 m wide; and
4. have a buffer zone of at least 25 m between multiple monitoring sites within the same prairie.

Volunteers may choose their own sites as long as they meet the minimum physical and safety requirements. EW realizes volunteer-selected sites do not necessarily reflect statewide prairie conditions due to their nonrandom selection. Therefore, CTAP and EW generated a list of 50 random sites and encouraged volunteers to adopt these sites. Approximately seven of these sites are currently monitored. Random sites will form the population from which to make statistical inference for statewide trends. These sites also provide a context in which to compare and place all nonrandom prairie data.

EcoWatch Program Work Cycle

PW typically trains new volunteers during the summer and conducts review sessions for veteran volunteers prior to both monitoring periods. The PW butterfly monitoring period runs from June 15 to August 1. New volunteers do not monitor and submit data for butterflies in their first year but are encouraged to practice during this time. The plant monitoring season runs from August 15 to October 1 statewide. Volunteers may also practice butterfly identification during plant monitoring (Table 2). Each site is monitored only every other year to reduce trampling effects. Volunteers

submit hard copies of all data sheets to their regional office and enter their data on-line (if possible) by November 1. EW staff check the data for errors and enter data on-line for volunteers without Internet access. There is a final data check by the Quality Assurance (QA) Officer. Each year the QA Officer checks any herbaria submitted by volunteers. The QA Officer also checks volunteer plant identification by conducting random site checks and verifying the species identified by volunteers. EW staff use the remainder of the year to evaluate potential sites and recruit volunteers.

TABLE 2. ANNUAL WORK CYCLE

Major Task Categories	J	F	M	A	M	J	J	A	S	O	N	D
Volunteer training & review sessions					X	X	X					
Volunteer recruitment	X	X	X	X	X	X	X	X	X	X	X	X
PW monitoring season						X	X	X	X			
Data entry										X		
Data entry QA/QC checks											X	X
Herbarium verification	X	X										X
Data analysis and reporting	X	X										
QA site checks (plant ID verification)								X	X	X		
PW site evaluations	X	X	X	X	X	X	X			X	X	X

7.0 DATA QUALITY OBJECTIVES FOR MEASUREMENT DATA

PW Data Precision

Precision is a measure of mutual agreement among repeated measurements of the same characteristic on the same sample or on separate samples collected as close as possible in time and place (U.S. EPA 1996). EW recognizes the need to assess both intra- and inter-observer precision.

Intra-observer precision addresses repeated measures of a method by the same person collecting data over time while inter-observer precision involves different people collecting the data over time.

EW has assessed inter-observer precision using shadow sampling (or duplicate sampling, the term used by the U.S. EPA), where two samples are collected at the same site (U.S. EPA 1998b) in other EW programs including ForestWatch and RiverWatch (Brandon 2002a; Brandon 2002b). Shadowing compares data collected by volunteers with those collected by EcoWatch staff (Trainers) from the same site. It is the responsibility of EW staff to train volunteers; therefore, the two groups should obtain similar results when using the same procedures. Currently, EW has yet to conduct shadow sampling for the PW program. However, FW shadow data indicate high precision between the two groups when identifying *Fraxinus, Acer, Quercus,* and *Ulmus* to the genera level (Brandon 2001). Species level identification between the two groups was also in high agreement for many trees including *Fagus grandifolia, Tilia americana, Robinia pseudoacacia,* and *Liriodendron tulipifera* (over 90% agreement in identification and abundance results).

Additional information on inter-observer precision could be derived from having multiple volunteers sample a single location; EW has yet to conduct such a test. PW is also aware of the issue of intra-observer precision. However, monitoring can take volunteers six hours or more. It may prove unrealistic to expect volunteers to monitor their sites twice.

PW Data Accuracy

Accuracy is a measure of confidence or closeness in an individual measurement and the difference between the individual measurement of a given parameter and its "true" or actual value (U.S. EPA 1998b). For plant identification, EW utilizes several methods to enhance accuracy. First, for training and review EW staff plan to compile and maintain plant reference collections. Each collection must include all common native prairie plants, common invasive shrubs, and trees. Whenever possible, collections also include the disturbance-sensitive species. Collections are curated with the help of the QA Officer.

The PW program ensures accurate plant identification at each site by 1) requiring herbaria for the invasive plants and 2) ground checking the native plants. First, all volunteers submit herbarium specimens for the invasive indicator species and all trees recorded on the data sheets with the following exceptions. Volunteers may opt to not collect *Pastinaca sativa* since handling it can cause severe allergic reactions. The QA Officer checks submitted herbaria for correct labeling and identification. Results are compared to volunteer identification using paired t-tests and descriptive statistics such as means and percentages.

Secondly, because many monitored prairies are designated Illinois Nature Preserves (where collecting specimens is prohibited) a different strategy was necessary for checking native plant identification. Therefore, starting in 2003 staff will ground check sites to ensure accurate identification of the native prairie indicator species. Since PW is a small program (in comparison to RiverWatch and ForestWatch) it will be feasible for staff to visit a set number of sites each year. Sites for the check will be randomly chosen and surveyed by staff within two weeks of the volunteer monitoring date. The QA Officer (along with fellow staff when available) plan to check 15% or a minimum of five sites (whichever is greater) monitored each year.

Strategies for evaluating the accurate identification of the butterfly indicators are still under review. One option would be for EW staff to offer certification events at regional locations for testing volunteers on butterfly identification. Volunteers who passed a certification test could then have their data highlighted in the database as being of "high" quality. This strategy would circumvent the need to go out with each volunteer at each site while they are monitoring.

In the future, PW plans to conduct a comparison study to examine the congruence and disagreement between volunteer and professionally collected data originating from the Illinois Natural History Survey (INHS). Botanists have resurveyed volunteer transects in the ForestWatch Program using their own equipment and identified all plants to species (Brandon 2002a; Brandon 2002b). Results from the FW study indicate volunteers can accurately identify the indicator shrub species.

There was also a high accuracy rate for most species of trees with a few notable exceptions (Brandon et al. In press). Volunteers were not consistently separating *Quercus* species from one another and also had difficulties with the *Ulmus* genus. However, both these genera can pose challenges to professionals due to hybridization among species and difficulty with positive identification during the sapling and seedling stages (Brandon et al. In press).

PW Data Representativeness

Representativeness, in the context of PW, is the extent to which data accurately represent plant community characteristics at the landscape scale (U.S. EPA 1998b). The PW sampling design is not intended to represent the botanic or butterfly community characteristics at the site level.

Representativeness of Illinois prairie tracts at the landscape level depends largely upon randomized prairie site selection. Placing nonrandom sites into the context of more representative, random sites permits direct comparisons between the two sampling schemes and still allows for trend analysis of nonrandom sites on a site-by-site basis.

The primary intention of PW is to assess habitat quality on a statewide level using multiple sites, not to accurately represent the plant community at each site. Therefore, a permanent transect approach was adopted in lieu of randomized sampling within a prairie tract. Permanent sampling units eliminate onsite variability attributable to differences in location, thus they are more powerful for long-term studies (Schwartz et al. 1997; Elzinga et al. 1998). For a more detailed discussion on the representativeness of random versus permanent transects when sampling a site, see section 10.0.

PW Data Comparability

Comparability in terms of PW data is the extent to which we can compare data across years and to other similar studies (U.S. EPA 1996). Comparison of multi-year data from the same site is made

possible by the use of standard operating procedures discussed throughout this Quality Assurance Project Plan and in the PW Manual (IDNR 2001b). This is the general approach espoused by the U.S. EPA for volunteer stream monitoring (U.S. EPA 1997). There are no standard operating procedures (SOP) for volunteer monitoring of terrestrial systems, but PW has adopted standardized professional monitoring methods whenever possible. For example, cover classes used to estimate coverages of plants are based on those used by professional scientists (Abrams and Hulbert 1987). Whenever possible, monitoring protocols were adopted from those used by the CTAP botanists (Carroll et al. 2003). For example, both programs sample along a single transect and estimate cover for 20, 1/4-m^2 quadrats (Table 3).

TABLE 3. COMPARISON OF PRAIRIEWATCH AND CTAP GRASSLAND MONITORING PROTOCOLS.

Protocol	CTAP grassland (professionals)	PrairieWatch (volunteers)
Transect length	41 m	50 m
% Cover estimates forbs & grasses	20, 1/4-m^2 quadrats	20, 1/4-m^2 quadrats
Shrub plot (stem density)	4- X 41-m belt (along transect)	4- X 50-m belt (along transect)
Tree & large shrub plot (> 5 cm dbh)	41- X 50-m belt (along transect)	50- X 50-m belt (along transect)
Level of plant identification	All plants to species	Trees to species, 32 indicator plants to species/genera
Terrestrial insect sampling	2, 50-m linear sweeps (100 sweeps each) along 3 m on both sides of plant transect. All insects are preserved & warehoused for later identification.	1-hour route (5 m on either side of route) walked to record the abundances and identification of 19 indicator butterfly species (no voucher specimens are made). Location of route is not along the plant transect.

If no standard operating procedures exist (as is the case with volunteer terrestrial monitoring) then the next best alternative is to document performance-based characteristics such as precision, accuracy, and representativeness of one's methods and to make direct comparison of one's data with other programs whenever possible (Diamond et al. 1996). Most performance characteristics of

PW data are planned but have yet to be conducted. PW data are comparable to professional CTAP data when using data subsets of the latter. Both groups collect comparable data. Specific differences and similarities are outlined in Table 3.

PW Data Completeness

Completeness is defined as a measurement of the number of samples one must take to be able to use the information, as compared to the original number of samples one planned to take (U.S. EPA 1996). In 1996, the goal was to have 50 random prairie sites monitored statewide by citizen scientists. Currently we have achieved approximately 14% of this goal. However, another six to eight sites are in the process of being adopted in 2003. Professional scientists with the CTAP program monitor 30 grassland sites per year, however from 1997 to 2001 only 14 of these sites were designated as prairie. In 2002, citizen scientists monitored 14 sites (including both random and volunteer selected sites). Therefore, volunteer prairie monitoring increased the total number of statewide monitoring sites by 100% (Table 4).

TABLE 4. NUMBER OF PRAIRIE SITES MONITORED BY VOLUNTEERS STATEWIDE BY WATERSHED 1998–2001; P = pilot years.

WATERSHED	1998 P	1999 P	2000	2001	2002
Rock	0	0	1	2	3
Fox	2	4	2	7	5
Kankakee	4	2	1	0	0
Spoon	0	0	3	2	1
Sangamon	2	0	5	2	1
Lamoine	3	0	3	0	3
Kaskaskia	0	0	1	1	1
Embarras	2	1	5	0	1
Little Wabash	0	0	0	0	0
Big Muddy	0	0	0	0	0
Total	*17	*7	22	14	14

The 1998 and 1999 data are considered pilot years for the PW program. During this time, procedures were tested and modified if necessary. *In a few cases the watershed for a site was not known. When this occurred it was only included in the totals.

8.0 TRAINING REQUIREMENTS

Citizen Scientist Training

Volunteers are required to attend a training session before they are eligible to collect data. Untrained volunteers may assist trained volunteers as long as they are supervised. Sessions typically consist of a one-day course encompassing both indoor and outdoor portions. Volunteers are trained using a standardized training session format. Standardization of session content and format provides consistency in volunteer training across regions and time.

The indoor training covers the program's goals, monitoring procedures, QA/QC, and site set-up. Volunteers also receive basic training on how to identify plants and are shown slides of the indicator prairie species. PW recognizes that additional practice is necessary for accurate species identification and it is the volunteers' responsibility to practice identifying and keying species on their own. During the outdoor portion, volunteers receive hands-on field training at a prairie site. Active participation is strongly encouraged during the field portion to ensure volunteers become comfortable with using the equipment and conducting the procedures.

Review Sessions

PW strongly encourages volunteers to attend review sessions each year. Topics discussed include updates to the program, manual revisions, and plant and butterfly identification refreshers. Reviews are fairly flexible in order to adjust to volunteer needs. PW periodically offers prairie walks and other field opportunities for volunteers to identify and learn prairie plants.

Volunteer Testing/Certification

A direct comparison to other volunteer monitoring QA programs is difficult since PW, unlike most

groups, collects terrestrial data. The closest comparisons possible are with volunteer stream and butterfly monitoring programs. Many stream volunteer programs require certification by testing (Maryland Stream Waders Program 2001; Virginia Save Our Streams Program 2001). However, many other volunteer programs do not do any type of data testing (Panzer et al. 2003).

Testing is not required for PW plants because the QA Officer will visit every site to verify the volunteer plant identification. Likewise, comparison and shadow studies will test if volunteers are following the data collection methods. Butterflies, however, offer a unique dilemma for PW since they cannot be verified by ground checks (unless the verifier goes out with each volunteer) or by the various studies. Alternative options for testing the butterfly data are currently under review (see section 7.0 for more information).

Volunteer Feedback

PW solicits feedback from its participants. Staff distribute Volunteer Feedback Forms to volunteers as part of the standard training packets. The forms are also given to all previously trained citizen scientists attending reviews. Responses are evaluated and any questions or errors are addressed by staff in as timely a manner as possible.

9.0 DOCUMENTATION AND RECORDS

Hard Copies

A hard file is kept for each PW monitoring site and contains the volunteer's contact information, landowner contact information, legal description, and site directions. This file acts as a backup to the site identification database available via the EW Intranet Web site. It also includes monitoring data

for the site and any QA information available for the volunteer. Each site file must include the following items:

1. **Site Evaluation Form** describing the site location, access points, and suitability of the site.
2. **Site Identification Form** describing the location of the site, legal description, and other location descriptor information.
3. **Property Access Agreement Form** documenting the landowner's permission to access the site for evaluation and monitoring purposes. It must be signed before monitoring starts.
4. Hard copies of the original **Data Sheets.**
5. **Site Maps**
6. **Copies of permits** are also included when applicable.

PW Computer Databases

The EcoWatch Database Manager maintains the PW site description and site evaluation databases at a statewide level. When a volunteer requests a site for adoption, the EW Database Manager reviews and confirms the following site information: site name, site location (watershed, county, location description, topographic map name, township, range, section, and section quadrant), and site coordinates (latitude and longitude). The tool used to review site location and coordinates is digital topographic software Terrain Navigator by Maptech.

If the site meets all evaluation criteria, the manager registers the site in the site database and assigns a unique identification number. This site identification number consists of eight digits; the

first is "P" for PrairieWatch, digits two–three represent the watershed number, digits four–six are the Federal Information Processing Standard (FIPS) code for county, and digits seven–eight signify the number of the site within a given county.

PW maintains a site database tracking system where sites are categorized as 1) unevaluated, 2) evaluated and ready for monitoring, 3) adopted by a volunteer, 4) abandoned by a volunteer who no longer monitors with PW, or 5) rejected as unsuitable for monitoring. PW also tracks whether a site is volunteer selected versus random. Abandoned sites remain in the database and are reassigned to another volunteer if they were randomly selected or if multiple year data were collected (over three monitoring seasons).

10.0 MONITORING DESIGN

Plant Monitoring Design Rationale

PW data characterize changes in prairie structure and habitat quality over time by monitoring a large number of sites distributed throughout the state. Therefore, the specific condition of any one site is less important than gathering trend data over time (Schwartz et al. 1997). In addition, the ability to detect temporal trends are much more powerful with permanent sampling units compared to temporary units (Elzinga et al. 1998). With this in mind, volunteers establish a permanent transect line at their prairie site. Additional reasons why PW opted for permanent transects include:

1. It simplifies site set-up and circumvents any issues with volunteer ability to select a random location within their prairie each time they monitor.

2. Any bias in transect location is minimized since volunteers do not monitor near where the baseline is established. Instead they measure out a 50-m transect line perpendicular to the 50-m baseline set-up at the prairie edge.

The permanent transects are separated into 10-m intervals for ease in collecting and recording the data. This also allows volunteers to more easily relocate individual plants they had difficulty identifying (Schwartz et al. 1997). In addition, the data can then be used to track the spread of the invasive indicators across the transect length over time.

PW adopted a basic vegetation sampling method to gauge trends in habitat diversity and prairie quality (Schwartz et al. 1997). One way volunteers examine major structural changes to prairies is by monitoring the coverage of grass and forb species and comparing changes in this ratio over time. Tracking the ratio of grasses to forbs is an indirect measure of the site's management. For example, while fire is an essential management tool for suppressing invasive and woody species, it can (if applied too frequently or at the same time every year) favor grasses to the detriment of forb species and overall site diversity (Collins et al. 1998; Howe 1994). Therefore, monitoring the ratio of grasses to forb coverages provides valuable information for effective management of prairie restorations or remnants.

The program measures the loss of disturbance-sensitive species from prairie sites as a key indicator of degrading prairie health (Schwartz et al. 1997). Using indicators is the most effective method for measuring prairie disturbance without burdening the volunteer with long species lists. However, EW recognizes that using indicators is loaded with biological prejudices regarding their actual importance to ecosystems (Schwartz et al. 1997). The study design avoids this problematic issue since we intend to utilize the indicator species data to track trends at a site through time, not to compare coverage of these species among sites. EW also recognizes that the majority of the indicator plants are mesic or upland adapted species (e.g., *Dalea candida* and *Ceanothus amiercanus*). However, the majority of remaining prairie is black soil mesic or dry mesic prairie (IENR 1994). Therefore, indicator plants represent those species most likely to be encountered by volunteers at a large number of monitored sites.

Historic records on disturbance-sensitive and invasive flora are often sparse, with information limited to a specific collection date and site. This type of record contains insufficient data on the magnitude of the impact or loss of such species from the state (Schwartz et al. 1997). The PW program fills a data gap by allowing one to quantify the impacts or loss of these species over time on a statewide basis. Disturbance-sensitive species are defined here as those species that often disappear from prairies through anthropogenic alteration of prairie disturbance regimes. Fragmentation, fire suppression, livestock grazing, and mowing are common examples of human-induced changes (Schwartz et al. 1997). Disturbance sensitive species were selected based upon the following criteria:

1. their presence in high-quality prairies;
2. an observed tendency for extirpation with human disturbance;
3. they are easily identifiable and not easily confused with similar taxa (Schwartz et al. 1997); and
4. the species coefficient of conservatism (Taft et al. 1997).

Volunteers collect information on the coverage of invasive grasses and forbs that are of concern for management and restoration efforts. These species are also good indicators of habitat quality. The invasive grasses and forbs:

1. are fairly widespread across prairies statewide;
2. are thought to have a negative impact on native prairie species; and
3. are easily identifiable and not easily confused with similar taxa (Schwartz et al. 1997).

Measuring invasive woody species density is also critical in monitoring trends in prairies. A high abundance of woody invasive plants is a strong indication of degraded habitat quality and lack of active management (IDENR 1994; Schwartz et al. 1997).

Butterfly Monitoring Design Rationale

Volunteers monitor the presence and abundance of 19 indicator butterflies species. Butterflies are good indicators of ecological health since many species have larvae that feed on high-quality prairie plants (Bouseman and Sternburg 2001). Butterflies are also highly sensitive to pesticide drift and fire regimes and therefore, indirectly measure their effects on prairie systems.

PW devised methods to enable a person with relatively little experience to assess changes in the abundance of butterflies for a set number of indicator species. Procedures are similar to those for the Illinois Butterfly Network but vary greatly from Ohio's Long Term Butterfly Monitoring Program. The most striking differences are in permitting capture of butterflies and the number of censuses per year. Unlike other programs, PW does not permit capture and release of butterflies (Panzer et al. 2003; Ohio Department of Natural Resources 2003). The rationale for avoiding capture was to minimize harm to rare and threatened/endangered species on the indicator list. For example, the Regal Fritellary is Illinois State Endangered (Bouseman and Sternberg 2001). Also, PW volunteers monitor a single time each season while most other programs take multiple census at each site per season. However, since the PW butterfly methods (as for plants) were designed to assess long-term trends across multiple sites instead of trends within a single site, having a single sampling period is adequate for PW monitoring purposes. A detailed comparison of three midwestern butterfly programs is in Table 5.

TABLE 5. A COMPARISON OF PROTOCOLS FROM THREE VOLUNTEER BUTTERFLY MONITORING PROGRAMS (OHIO DEPARTMENT OF NATURAL RESOURCES 2003; PANZER ET AL. 2003; IDNR 2001B)

	PW Protocols	Ohio Protocols	Illinois Butterfly Network Protocols
Monitoring season	June 15–August 1	April 1–September 30	June 1–July 31
Number of censuses	1 per season	26 per season	4–6 per season
Fixed route used?	Yes	Yes	Yes
Capture and release permitted?	No	Yes	Yes
Width of route	Within 5 m either side of route	Within 7.5 ft. (2.3 m) either side of route	Within 6 m either side of route
Length of route	Approximately 1hour (walking 1 mph)	Even pace Not known	1 to 2 hours
Wind speed	Light to moderate	Light to moderate	Light to moderate
Cloud cover	Less than 50%	Varies depending on air temperature	Less than 50%
Hours of census	10 AM to 3 PM	11 AM to 5 PM	10 AM to 3 PM

Additional Data Collected

Volunteers characterize their prairie site's basic geography, size, land use, management, and surrounding land cover. This information provides additional information on expected plant diversity (related to remnant size), outside pressures from surrounding land uses, and potential causes of prairie degradation. It may also be used to determine whether management or restoration activities are being effective.

Safety and Liability

Personal safety is a high priority for the PW program. Volunteers are instructed to never monitor a site alone. Volunteers are also instructed to use the following precautions:

1. always let someone know where you are going and when you plan to return;
2. wear covered shoes and long pants when monitoring; and
3. take proper precautions to avoid poisonous plants, snakes, biting insects, and ticks.

All citizen scientists are required to sign liability waiver forms when attending training sessions or other events sponsored by EW. In addition, the EW Property Access Agreement Form states that landowners are not responsible for injuries or damages that may result when citizen scientists monitor a site.

11.0 EQUIPMENT REQUIREMENTS

Equipment

Volunteers must use the equipment listed in the *Illinois PrairieWatch Monitoring Manual* (IDNR 2001b). Most volunteers borrow equipment; however, a few procure their own equipment. An abbreviated list of required equipment includes the following:

1. meter sticks and meter tape (or polypropylene rope marked in meters);
2. plastic or metal tent stakes;
3. compass;
4. plant identification keys;
5. PW indicator cards for both plants and butterflies; and

6. 1/4-m^2 quadrat.

12.0 HERBARIUM LABELING AND CUSTODY REQUIREMENTS

Volunteers are required to submit a herbarium collection of all the trees and invasive indicator species identified during monitoring. Once reviewed, collections can be used as a reference collection. All specimens are labeled with the following information:

1. scientific and common name;
2. PW site identification number and name;
3. county;
4. date collected; and
5. citizen scientist name(s).

13.0 INSTRUMENT / EQUIPMENT PURCHASE, INSPECTION, AND MAINTENANCE REQUIREMENTS

PW constructs the majority of equipment from materials purchased at local hardware stores. Equipment is available to volunteers at strategically placed local checkout stations. EW staff periodically check kits for missing equipment and damages.

14.0 DATA AND METHOD ACQUISITIONS

Size Classes, Cover Classes, and Diameter at Breast Height (DBH) Measurements

The PW program uses size classes to estimate dbh of trees and shrubs, and to estimate the percent cover of herbaceous species. DBH is the standardized method used to measure the size of woody plants. The use of classes was adopted to reduce volunteer error and to minimize time spent on the procedures. In addition, size classes are sufficient for PW purposes since volunteers are not measuring the growth rates of individual plants but monitoring general trends in the plant community (Schwartz et al. 1997). Volunteers follow standardized protocols for measuring trees based upon those used by the USDA Forest Service's Forest Health Monitoring Program (1999). The percent cover classes are based on the modified Daubenmire Scale (Abrams and Hulbert 1987) used by professional scientists when collecting percent cover data. However, for purposes of simplification, the classes were reduced to six categories instead of the seven used in the modified Daubenmire Scale and by professional botanists with CTAP (Table 6).

TABLE 6. SIZES CLASSES USED BY VOLUNTEERS AND THE PROFESSIONAL CTAP BOTANISTS; DBH > 60 CM IS RECORDED TO EXACT DBH; NA = NOT APPLICABLE.

Size Classes	PW DBH Scale (cm)	PW % Cover Scale	CTAP DBH Scale (cm)	CTAP % Cover Classes
A	5–10	0	5–9.9	<1
B	10.1–20	0.1–5	10–14.9	1–4.9
C	20.1–30	6–25	15–19.9	5–24.9
D	30.1–40	26–50	20–24.9	25–49.9
E	40.1–50	51–75	25–29.9	50–74.9
F	50.1–60	76–100	30–39.9	75–94.9
G	>60	NA	40–49.9	95–100
H	NA	NA	50–59.9	NA

Interpreting the Data

The PW program analyzes the data employing descriptive statistics frequently used by professional biologists. Examples include grass versus forb cover, number of invasive shrub stems, coverage of invasive species, and coverage of disturbance sensitive species per hectare.

Trend Analyses

It is the intention of the PW program to detect trends in prairie habitat quality once a sufficient data set is collected (Table 7).

TABLE 7. PRIMARY AND SECONDARY RESPONSE VARIABLES FOR PRAIRIEWATCH HABITAT QUALITY TREND ANALYSES (SCHWARTZ ET AL. 1997).

Protocol	Primary Response Measures	Secondary Response Measures
Woody structure (dbh, stem density, and species data)	Aggregate of densities in each dbh size class; number of stems for all taxa	Size class distributions and stem abundance by taxon
Invasive species (herbaceous)	Summed score of percent cover score for all taxa	Mean percent cover by taxon
Indicator plant herbaceous cover	Standardized mean percent cover for all taxa, ratio forbs /grasses	Mean percent cover by taxon /group
Indicator butterflies	Standardized mean abundance for all taxa	Mean abundance by taxon

15.0 DATA MANAGEMENT

Hard Copies

PW adheres to strict guidelines when recording and verifying data sheets. Verification boxes and standardized guidelines help to reduce errors. PW requires volunteers to check their data sheets for

completeness before leaving their site and to initial verification boxes on each sheet. Volunteers submit their original data sheets to EW where they are subsequently checked again for errors and initialed by EW staff.

On-line Data Entry

Volunteers who have access to the Internet and agree to enter their data on-line are given a username and password to access the Web site. The Web site allows volunteers to enter data only for their own site(s). Volunteers do not have access to data entry for other sites. EW staff enter data on-line for volunteers who do not have access and EW staff can access all sites to review data for errors. In all situations, the on-line data are compared to the original data sheets and staff corrects any errors.

16.0 DATA REVIEW, VALIDATION, AND VERIFICATION REQUIREMENTS

Minimum Data Requirements

The QA Officer reviews all data for verification purposes and has the final decision of accepting or rejecting data. The QA Officer follows these minimum guidelines:

1. Citizen Scientists must monitor their site using the procedures as described in training and in the *Illinois PrairieWatch Monitoring Manual*.
2. Citizen Scientists must use PW-approved monitoring equipment.
3. The site must be monitored within the specified PW monitoring period.
4. The site monitored must meet minimum safety requirements and have all necessary paper work complete, including site identification number and landowner permission.
5. There must be at least one trained citizen scientist present when monitoring a site.

6. Partial data sets are accepted if a given procedure was completed (for example the butterfly data or the plant data alone).

7. The prairie tract must meet the physical requirements (see prior sections for more information).

Addressing Minor Errors

PW accepts all data with minor changes. If small pieces of information are missing, such missing dates, names, or tree codes are corrected by contacting the volunteer for clarification. Documentation of any changes is inserted in the site file.

Data Verification

All data undergo a rigorous quality control process. Verification boxes are on each data sheet and must be initialed by volunteers and staff to ensure all data sheets are reviewed. EW staff who enter data for volunteers (who do not have access to the Web site) check the data using the following system: 1) a person enters the data and then waits a minimum of 24 hours before rechecking the data for errors or 2) one person enters the data and another person checks it for errors. Staff compare volunteer-entered data to the original data sheet in all situations. The QA Officer completes a final check of the data before posting. The QA Officer rejects data not meeting minimum requirements (see above).

17.0 VALIDATION AND VERIFICATION METHODS

Herbarium Reference Collections

EW maintains a Herbarium Reference Collection for use in training and specimen verification. All reference collections include a minimum of one specimen for each common native indicator (e.g., big

bluestem) and invasive indicator (sweet clover) on the PW plant list. The disturbance-sensitive prairie plants are included in the collection whenever possible. Specimens are identified using approved identification guides. The QA Officer may check the collections periodically.

Site Sketch Checks and Relocating Transects

Staff review all site sketches for completeness. Sketches must include compass bearings and multiple reference points to all the stakes, and enough detail to ensure transects can be relocated. The QA Officer periodically requests a random number of site files for review and will check the site sketches for completion. If a site is randomly chosen for a plant ground check, the QA Officer may opt to update the sketch (if necessary). Any changes to the sketch will be inserted in the site file.

Herbarium Checks by QA Officer

The QA Officer verifies submitted volunteer herbaria for the invasive indicators and all trees and shrubs. PW may ask volunteers to resubmit specimens in poor condition or species that were initially misidentified. Once a collection is submitted, the QA Officer identifies all pressed specimens. The QA Officer's findings are then compared with the volunteer's identification. The QA Officer provides each volunteer with information on their identification skills as well as the condition of the collection (see section 21.0). PW returns checked herbaria to the volunteer for use as a reference collection. The QA Officer tracks the status/progress of herbaria submittals. Sites with completed, verified collections are kept in a site tracking database.

Volunteer Site Checks

Starting in 2003, the QA Officer will verify volunteer identification of the native indicator plants during site visits. The goal is to check a minimum of 15% of monitored sites or five sites each year, whichever is greatest. Data collected by the QA Officer will be compared to the volunteer data to ensure volunteers are identifying the species correctly. The QA Officer will inform the volunteer via letter of any possible misidentified plants.

Possible methods for verifying the butterfly data are still under review. EW may opt for certification by testing or by observing and verifying volunteer identification while they are monitoring the butterflies or a combination of both.

Shadowing and Comparison Studies

PW plans to implement comparison and replication studies to ensure data quality. PW uses two major types of studies to quantify data quality. First, the precision or repeatability of PW data is checked through replication studies where trainers or other EW staff duplicate volunteer monitoring efforts. This is an effective tool for documenting training quality since the volunteers' data may be compared with data from staff certified in the procedures (Diamond et al. 1996). Sites to shadow are chosen randomly statewide and both sets of data are collected within a set timeframe (usually within two to three weeks of one another) to ensure consistency in site condition. This is also a blind study where volunteers are not apprised of the study or at least the exact purpose of the study. If results vary widely between the two groups, procedures or training protocols may be reviewed or changed to improve data quality.

Second, EW plans to examine the congruence of volunteer data with that of CTAP professional scientist data (details were discussed in sections 7.0). This study is essential for ensuring that PW data are comparable with data collected by CTAP botanists. Because volunteers do not identify all plants to species, this type of study will allow PW to quantify differences between professional- and volunteer-derived data

18.0 DATA ASSESSMENTS AND RESPONSE ACTIONS

Assessments and Response Action

PW staff corresponds periodically with volunteers to relay information concerning data quality. All correspondence with individual volunteers is documented and kept in the site file. Submitted data are reviewed and feedback given to volunteers in order to correct any problems.

PW encourages all volunteers to improve their identification skills and attend reviews. With this in mind, PW provides multiple opportunities for volunteers to polish their monitoring skills, including review sessions, tree/wildflower walks, and individual assistance by appointment. Staff also design outreach activities to address any current QA concerns.

QA Officer Assessments and Response Action

The QA Officer communicates data errors to fellow staff and volunteers via letters, reports, newsletter articles, or verbal communication. For example, the QA Officer informs staff of species with poor identification rates (thus far not applicable to PW but has occurred in both ForestWatch and RiverWatch). In turn, staff emphasize these species at training, review, and during personal communication with volunteers. PW rejects data not meeting minimum data quality requirements; however, currently PW accepts data with errors other than those described previously (see section on minimum data requirements). The program corrects any known errors (such as plant misidentification) and informs volunteers of the error.

19.0 REPORTS

The *PW Summary Report* consists of the data results for the entire state. The report includes but is not limited to the following information:

1. Descriptive statistics for an average prairie site's species richness, species abundance, and cover of indicator species.

2. Total number of prairie sites monitored statewide and by watershed. These data are also compared and discussed in reference to previous monitoring years.

Special Reports

The QA Officer also produces special reports on shadowing and comparison studies. Shadow reports often include but are not limited by the following:

1. Comparisons between volunteers and EW staff results for the site.

2. Rate of agreement between the two pairs of data for the plant species identified.

3. Recommendations for improving data quality.

Report Distribution

All reports are available on-line at the EW Web site. In addition, staff may use portions of these reports in feedback letters, newsletters, and in other materials sent to volunteers. Finally, these reports are sent out to all EW staff, relevant CTAP staff, and to volunteers.

20.0 RECONCILIATION WITH DATA QUALITY OBJECTIVES

Precision

EW is working to address both intra- and inter-observer data precision. Currently, we have not conducted such studies for PW (Table 6). A previous ForestWatch shadowing study found no difference between volunteer and EW staff results for identification at the genus level but did identify species-level discrepancies with the elms, oaks, and other difficult species (Brandon 2001)

Accuracy

PW strives to meet a minimum 80% accuracy rate for species identification. PW does not have accuracy levels available for the plant and butterfly indicators since PW has yet to conduct such checks. The QA Officer plans to use a combination of checking herbaria with ground checks to ensure correct plant identification starting fall 2003. EW is still evaluating methods for verifying correct butterfly identification.

Representativeness

PW data are representative of statewide prairie conditions since many sites are randomly selected. It is not the intention of the sampling design to accurately represent habitat quality conditions across an entire prairie site. A justification for the sampling design was previously discussed in sections 7.0 and 10.0.

Comparability

Data comparability from the same sites over time is maintained by the use of standard operating procedures, which were discussed throughout this report. PW data are also comparable to professional CTAP data when using data subsets. In an ideal world, both volunteers and

professional scientists would collect data using the same methods. However, using the same method is not likely among different agencies with different reasons for collecting data and varying levels of technical skill (Barbour et al. 1999). Whenever possible, PW adopted the methods of similar monitoring programs both professional and volunteer. The best alternative (when the same methods are not possible) is to document performance-based characteristics such as precision, accuracy, and representativeness of one's methods so that direct comparisons can be made with other programs (Barbour et al. 1999; Diamond et al. 1996). Performance-based characteristics of our data have been initiated but there is still a great deal to accomplish. PW has not made direct comparisons of our data with other similar monitoring groups. PW would be interested in conducting such a study in the future.

Completeness

The original goal for PW was to monitor 50 randomly selected sites statewide. Currently we have approximately seven randomly selected sites monitored by volunteers (Table 4). Therefore, we have yet to reach this data quality objective.

TABLE 8. CURRENT STATUS FOR MEETING PW DATA QUALITY OBJECTIVES (DQO).

	Inter-observer precision	Accuracy	Representativeness	Comparability
A. Monitoring Procedures				
Plant identification (native and invasive)	NE	NE	NA	Used SOP's for identif species
Butterfly identification	NE	NE	NA	Used SOP's for identif species
Coverage of plant indicators, shrub, & tree survey	NE	NE	NA	Used SOP's based upo botanists protocols
B. Site Procedures				
Estimating site's size; topography, land uses, land cover	NE	NE	NA	NA
Random sites statewide	Met DQO	Met DQO	Met DQO	Used SOP for randoml selecting sites
Randomness within site	NA	NA	NA	NA
# of sites monitored	NA	NA	NA	NA

SOP = standard operating procedures
DQO = data quality objectives
NA = not applicable
NE = not studied/addressed at this time

21.0 PW INTERNET RESOURCES

The following is a list of resources available at the PW Web site related to QA with a brief description.

- PrairieWatch Web page:

  http://dnr.state.il.us/orep/ecowatch/PrairieWatch/index.htm

- Downloadable database(s) for all prairie data starting in 1998:

  http://dnr.state.il.us/orep/ecowatch/DATA/Data1.htm

- *PW Methods Manual* detailing how the data are collected and organized in the database:

  http://dnr.state.il.us/orep/ecowatch/PrairieWatch/PWUSERGD.htm

- PW butterfly identification (with pictures)

  http://dnr.state.il.us/orep/ecowatch/PrairieWatch/butterfly/index.htm\

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